APPLICATION FOR

UNITED STATES PATENT

in the name of

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for

Metal Framing Member and Method of Manufacture

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CLAIM OF PRIORITY

This application claims priority to U.S. Patent Application Serial No. 60/401,084, filed on August 5, 2002, the entire contents of which are hereby incorporated by reference.

TECHNICAL FIELD

This invention relates to building materials, and more particularly to a metal framing member for structural and non-structural building applications.

BACKGROUND

The use of light gauge metal framing members for structural and non structural applications has grown in the residential and light commercial building industry due, in part, to volatile lumber costs and the inconsistent and unpredictable quality of wood studs. Although the use of metal in framing applications has increased over the last few years, a few issues have resulted in the rate of growth being inhibited. Exemplary issued include the relatively high cost of manufacturing the metal members and the high of the thermal conductivity. For example, metal members transmit cold and heat at a rate significantly higher than wood counterparts. While composite materials of wood and metal can help resolve the thermal conductivity issues, increased cost can result.

SUMMARY

A framing member including a series of slots along a portion of the member can be expanded during manufacture. The expansion of the slots creates an expanded region that includes voids and metal web elements in the framing member. The voids created during the expansion process can be used for running wiring, plumbing and heating ducts. The expanded slots can be designed to minimize thermal transmission from the exterior to the interior of the wall of the finished structure and can provide adequate structural properties for the application. The expanded slots can allow the dimensions of the part to enlarge without increasing the amount of raw material, which can substantially reduce the cost to manufacture the member. For example, the expanded slots can create a condition where the cost of raw material to produce the member is reduced by as much as 30 to 50%, for

example, 40%, as compared to metal member technology that does not include the expanded slots, such as punching or pressing to form voids.

In one aspect, a metal framing member includes a formed sheet of metal with a series of slots created in a region of the member. The region can be expanded in the manufacturing process to create voids and web elements in the region of the member. The member can exhibit desired dimensional and structural and thermal performance based on customer requirements at a more affordable price. Framing members include both structural and non-structural member designs.

In one aspect, a metal framing member includes a formed metal sheet including a plurality of expanded web slots in a region of the formed sheet metal.

The expanded web slots can include voids and metal web elements in the region of the framing member. The formed metal sheet can include a web region and a first flange extending from the web region. The formed metal sheet can include a second flange extending from the web region in a direction substantially parallel to the first flange. In some embodiments, the formed metal sheet can includes a closing region extending the first flange to the second flange to form a substantially tubular structure. In certain embodiments, one or more of the web region, the closing region, the first flange and the second flange includes the expanded web slots.

In another aspect, a preexpanded metal framing member includes a formed metal sheet having a length and including a web region and two flanges, each flange extending from the web region, and a plurality of web slots extending along a portion of the length in the web region or at least one of the flanges. The flanges can extend from the web region in a direction substantially parallel relationship. The formed metal sheet can include a closing region extending between the flanges. The web region, each flange, the closing region, or combinations thereof, can includes the web slots.

In another aspect, a method of manufacturing a framing member includes providing a formed metal sheet having a length and a web region, and placing a plurality of slots along a portion of the length in the web region. The formed metal sheet can be provided by roll forming a metal sheet. The plurality of slots can be placed by piercing or stamping slots into the region. The method can include expanding the slots of the web region to form expanded slots having a web element and a web void, for example, by passing the formed metal sheet over a tapered block or mechanically moving sides of the region apart. The method can also

include reinforcing the expanded formed metal sheet, for example, by placing a flange or dart in the web element. The method can include placing a plurality of slots along the length in each of a first flange and a second flange of the formed metal sheet, which can be expanded. The plurality of slots can be placed by arranging the slots in offset columns substantially parallel to a length of the member. The method can include heat-treating the member after expanding the slots.

In another aspect, a method of building a structure includes placing an expanded framing member in a portion of the structure. The expanded framing structure can include a plurality of expanded web slots forming a plurality of voids in a region of the framing member. The method can include installing wiring, plumbing or a heating duct through at least one void of the member.

Each slot can extend along a portion of a length of the member. For example, the plurality of slots can be arranged in offset columns substantially parallel to a length of the member, to form, e.g., three or more (e.g., 5 or more) columns of slots along the length of the member. The member can include reinforcements in the web elements, which can include flanges or darts.

Advantageously, the expanded framing member provides a design that can reduce the production costs of the of light gauge metal framing members used today in residential and commercial construction by cutting slots in the web area of the metal member and expanding the web-area through a manufacturing process. The expansion creates and openings web elements that connect the flanges of the member without forming voids or holes by cutting and scrapping the material at a substantial cost penalty. Thus, this concept substantially eliminates manufacturing scrap, creating structurally and dimensionally stable members at significantly reduced cost as compared to manufacture of nonexpanded framing members. The structure of the expanded web can be enhanced by creating dimples and flanges at strategic locations during the manufacturing process.

The expanded framing member also can have a design that can reduce the rate of heat transfer through the member by, for example, controlling the quantity, width and length of web elements of the members. For example, a thin and long web element can reduce the rate of heat transfer from one flange to the other resulting in improvement in the overall R-Value of the wall incorporating the expanded framing member. For example, a recent study performed on several alternative designs showed that large voids produced in the web area

decrease of the stud can decrease the thermal transfer rate by a much as 50% when compared to a standard available metal stud.

In another advantage, the voids created during expansion in the web area can facilitate the installation of wiring and plumbing through the wall in a manner that tradespersons are accustomed to dealing with. This can be achieved by developing the shape and size of the openings created by the configuration of the web slots and web elements.

The details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features, objects, and advantages will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

FIG. 1 is a perspective view of a portion of the member with forming complete and web created but prior to expansion into final configuration.

FIG. 1a is a perspective view of the member of **FIG. 1** with forming complete, web slots created and expanded into its expanded configuration.

FIG. 2 is a perspective view of a portion of a member with insulation strips shown attached to the flanges.

FIG. 2a is a section view of the member of **FIG. 2** with insulation strips shown attached to the flanges.

FIG. 3 is a perspective view of a portion of a member with darts and flanges shown in locations of the member.

FIG. 3a is a section view of the member of **FIG. 3** through a darted area showing a typical configuration.

FIG. 3b is a section view of the member of **FIG. 3** through a flanged area showing a typical configuration.

FIG. 4a-4e are section views showing alternative flange configurations that could be used in conjunction with the expanded web.

FIG. 5 is a perspective of a portion of a member with expanded web in the flange area.

FIG. 6 is a perspective view of a portion of the member in a tubular configuration with forming complete, web slots created but prior to expansion.

FIG. 6a is a perspective of the member of **FIG. 6** with forming complete, web slots created and expanded.

FIG. 7 is a perspective of a portion of a tubular section with expanded web design on both the web area and flange area.

FIG. 8 is a perspective of a portion of a member with an alternative web slot and web element configuration.

FIG. 9 is a perspective of a portion of a member with an alternative web slot and web element configuration.

DETAILED DESCRIPTION

A framing member can be manufactured by expanding metal in a web region, a flange region, or both, during the manufacturing process. Slots can be formed in a pattern such that the region can be expanded during the manufacturing process. The expansion creates the voids and web elements that extend at least one dimension of the framing member. The voids can create thermal resistance which reduces the thermal conductivity of the member and improves R-value of the ultimate structure. Because the metal is expanded, there is little or no scrap metal produced during manufacture.

FIG. 1 is an isometric view of a portion a framing member **100** prior to expansion into the final configuration but with the web slots **103** pierced into the web area. The placement, shape and length of the web slots **103** in a region having dimension **a1** determine the width and length of the web elements **102** as well as the shape and size of the web voids. Flanges **101** extend away from the web region. The member can be manufactured in part or in whole through a roll forming process. Alternatively, a stamping process can be used to manufacture the member. The member can be manufactured from steel or aluminum, or any other suitable metal in sheet form. The sheet can have a thickness of, for example, 24 to 10 gauge.

Referring to FIG. 1a, which depicts an expanded framing member, the typical dimension **c** of flange **101** can be approximately 1.5 inches, although it can be adjusted for different applications. Web area dimension **a1** in the region increases during the manufacturing process by expanding the slots to become significantly wider until the web area reaches the final dimension **a2** is shown on **FIG. 1a**. The final quantity, shape and width and length of the web slots determine the size of web voids **104** and web elements **102** are

selected to optimize all of the objectives and limitations of the material to be formed into the final shape. Optimization will depend upon specific customer needs. Dimension **b** can be 2.5 inches to 11.5 inches but can be higher if required. The final member length **d** can be 92 to 120 inches for wall studs and 2 feet to 20 feet for structural elements such as floor joists, although, generally, dimension **d** can be any length.

The framing member can be manufactured by a process, for example, that includes passing a sheet of metal from a coil through a series of form rolls that create the structural shape of the framing member. During the roll forming process, the web slots are pierced into the region to be expanded, such as center web area **b**. The piercing can be performed with a stamping die, a configured roll, laser or any other suitable method of creating the web slot. The web slot configuration can be adjusted to accommodate any desired shape or length in order to create a web void or web element that enhances the thermal performance, cost reduction, tradesperson access, structural enhancement or any other desired objective not currently realized.

After the web slots have been incorporated into the region of the member, the member can be expanded by moving the flanges perpendicularly opposed to one another until the desired width **a2** is obtained. The expansion process can be performed in several ways including passing the member over a tapered forming block during the roll forming process. For example, the unexpanded member can be forced over a tapered forming block that fits between the two flanges. As the flanges move down forming line and over the tapered forming block, the flanges move progressively apart until reaching the desired width **a2** shown in **FIG. la**. An alternative to a tapered forming block can be rolls or a block including rolls attached to the forming block. An alternative method of expansion by rolling can include expanding using a mechanical or hydraulic mechanism that locks onto the flanges on the member and move them apart to the desired width **a2**. The expansion can extend a dimension by a factor of 10% to 300%, 20% to 250%, or 50% to 100%.

The final width determines the overall width of the member as well as the final configuration and dimension of the of the web voids. After expanding, the member can be heat treated to strengthen a portion of the member, for example, by heating the portion of the member for a period of time, or the entire member, and quenching the member. The member can have a yield strength of between 10 and 100 ksi, or 30 to 60 ksi, for example, 33 ksi or 50 ksi.

Referring to **FIGS. 2** and **2a** an insulated strip **201** can be attached to the flange **203** by adhesive, staples, nails or other similar fasteners. The insulated strip can be made of wood, plastic, or other materials that can function as both a thermal insulated barrier fire resistant and exhibit characteristics that would allow conventional nailing. This can allow the use of nail guns and other automated tools normally used for attaching the structural members together and sheathing to flanges. This configuration can have insulated strips on either one or both flanges of the member.

FIG. 3 is perspective showing an expanded web framing member made with optional flanges **302** and darts or dimples **301** that can enhance the structural properties of the web elements, and the member. The expanded slots form regions of stress in the member, which can enhance or degrade the structural properties of the member. The darts or dimples, or flanges, can reduce stress in the member introduced during expanding, thereby strengthening the member. The flanges and darts can be incorporated, for example, during the roll forming operation of manufacture, or by stamping or rolling in to the sheet prior, to or after the shaping operation. The shape and configuration of the darts and flanges can be adjusted to any length, shape or depth in order to achieve the desired objectives. **FIG.3a** shows a cross section of the member of **FIG.3** through the flanged area of the web element and depicts flanges **302**. **FIG. 3b** shows a cross section of the members of **FIG. 3** through the dimpled or darted area **301**.

FIG. 4a-4e show a cross section of various members with alternative flange configurations **402** that can be applied to the expanded framing member. The effectiveness and benefits of the expanded web design can be enhanced by the different configurations of the flanges, however, any alternative flange configuration can generally be used.

FIG. 5 is a perspective of a framing member **500** that includes web slots **503** and web elements **502** within the flange **501** of the member.

FIG. 6 and **FIG. 6a** depict an alternative framing member **600** made of a tubular section **610** having web region **601**, flanges **602**, and closing region **608**. **FIG. 6** is the member **600** shown prior to expansion and **FIG. 6a** is the member **600** shown in the final expanded form. The tubular section can exhibit improved torsional rigidity as compared to an open "C" section (see, for example, the member of FIG. 1). The improved torsional rigidity can be desirable in some structural applications.

FIG. 7 is a perspective of another member **700** similar to the one shown in **FIG. 6a**, which includes web slots and web elements within the flange of the member.

FIGS. 8 and **9** depict perspective views of members **800** and **900**, respectively, that include varied web element **802** and **902** and web void **902** and **903** configurations. It is important to state that the configuration of the web slots and web elements are determined on a case-by-case basis. These alternatives shown are only examples and are not meant to be limiting.

A number of embodiments have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the concepts described above. For example, the expanded framing member concept can apply to other structural members such as floor joists, in which the web slots can be designed to create web elements capable of withstanding a structural load. If required, the web slot and web elements can have darts and flanges added to create strength. Accordingly, other embodiments are within the scope of the following claims.